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Mechanical Sampling of....

COTTON

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Marketing Research Report No. 412

UNITED STATES DEPARTMENT OF AGRICULTURE
Marketing Economics Research Division
Agricultural Marketing Service
and
Marketing Division • Farmer Cooperative Service

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ACKNOWLEDGMENT

United States cotton producers, ginners, merchants, spinners, sampler manufacturers, and Government classers provided most of the information given in this report. Their cooperation in this connection is gratefully acknowledged.

July 1960

SUMMARY AND CONCLUSIONS

During the past 5 years mechanical devices for sampling cotton bales during ginning have been installed in approximately 153 United States gins. Over 90 percent of the mechanical samplers are in Texas and California. About two-thirds of them were installed during 1959. Nearly three-fourths of the total are in large-volume gins owned cooperatively by farmers.

The mechanical method of sampling, originally developed by researchers of the U. S. Department of Agriculture, was designed primarily to overcome the main shortcomings of the conventional method of cutting the bale. These shortcomings are the limited proportion of the individual bale represented by cut samples, the ragged appearance and surface contamination of the bales, and other disadvantages attributable to cutting holes in two sides of the bale.

This study was made to provide information helpful in evaluating the two methods of sampling and in recognizing and overcoming barriers to the wider use of mechanical sampling. The information was obtained mainly during 1958 and 1959 by personal interview and by mail questionnaire from representatives of the domestic cotton industry, sampler manufacturers, and others with experience relating to both mechanical and conventional sampling.

Three different makes of mechanical samplers are in use. Each possesses distinctive features, but they all extract, accumulate, press, and package a series of subsamples taken at intervals while the bale is being ginned. The initial package--generally containing 7 to 10 subsamples and either 18 or 27 inches long--is usually cut into two or three samples approximately 9 inches long.

A good many producers, ginners, and others apparently take for granted that mechanically drawn samples of ample size are better than cut samples.

Actually, however, this depends upon (a) the distribution of the subsamples throughout the bales, and (b) how well, on the average, the subsamples represent the parts of the bale from which they were taken.

Checks by USDA in October 1959 showed that in many instances the distribution of the subsamples was considered unsatisfactory. Immediate steps were taken by the Department to help correct this situation by requiring, among other things, a minimum of seven subsamples with one taken during both the first and the last 60 seconds of ginning time. Limited studies made in 1954-55 on USDA-owned experimental samplers indicated that these models, when properly installed and operated, gave samples and subsamples which were generally considered to represent the bales at least as well as cut and hand-drawn samples and subsamples. These studies and other available information indicate, however, that mechanical samplers must be installed and operated with care. Otherwise, the resulting samples and subsamples may inadequately represent the bale or portion of the bale from which extracted.

Comparative costs of the two methods of sampling are also important to those contemplating the use of mechanical samplers. It is estimated that in 1958 the costs of owning and operating a mechanical sampler that makes 18-inch packages ranged from about 33 cents per bale sampled at an annual volume of 9,000 bales to 45 cents at an annual volume of 4,000 bales. These estimated costs were between 16 and 22 cents per 9-inch sample. For the larger units which give three samples, the estimates are somewhat greater per bale, but about one-fourth less per sample. The above costs are for gins with annual volumes two or more times as large as the U. S. average. Consequently, for gins with only average volumes, corresponding costs per bale and per sample would be much greater.

Comparable costs of the initial cut sample obtained from each bale vary greatly, even within a given State, depending upon local practices and customs. From the limited information obtained, it is estimated that the 1958 costs to farmers in California, where most mechanical samplers were located, ranged from 3.5 cents or less per bale and per sample to 57.5 cents or more. At some gins, if the cotton is sold on gin weights made prior to sampling and if the buyer pays the same price for gin weight as for warehouse weight bales, the producer would have no direct or recognizable cost.

Many of the ginners and farmers contacted indicated a preference for mechanical sampling. Their main reasons were (a) they considered these samples to be more representative of the bales, and (b) this method eliminated or reduced the cutting of the cover and the outer surfaces of the bales.

Most cotton classers felt that these samples were equal to or better than cut samples in representativeness, but some--especially those in cotton shipping firms--believed they would generally give a lower quality outturn than cut samples. Four spinners' representatives having recognized experience with mechanical samples reported that they considered the two types of samples equally representative of the bale contents. Three of them reported that their classers had made checks with both types of samples.

Several factors retard the use of mechanical sampling in United States gins: (1) the high costs per bale in gins with annual volumes no greater than the approximately 2,000-bale average for all domestic gins, (2) the complicated features of samplers, (3) the longstanding domestic practice of obtaining fresh cut samples on many of the bales each time they are sold and sometimes when offered for sale but not sold, and (4) the difficulty of obtaining mechanically drawn samples which always include subsamples taken from the thin outer portion of the bale from which the fresh samples are cut. To help overcome these barriers, particular attention should be given to the development of more simple and less expensive mechanical sampling devices, and to the possibility of reducing the need for fresh samples.

MECHANICAL SAMPLING OF COTTON

by Maurice R. Cooper, J. D. Campbell, and
D. L. Pritchard 1/

INTRODUCTION

Samples drawn from baled cotton are the basis for determining the grade, staple length, and other quality factors used in buying and selling United States cotton. Consisting of only a few ounces of cotton, these samples are intended to represent the entire contents of the bale. The dependability of the samples, how they are drawn, and the number taken are important to all segments of the cotton industry.

Historically, the conventional method of sampling cotton in the United States has involved the manual operation of cutting an opening about 6 inches wide by 1 to 2 feet long in two sides of the bale and removing a portion of cotton from each of these openings. The two portions are placed together to form an individual sample, and generally a numbered coupon is placed in the center for identification. A new sample is generally taken for each change in ownership, and at times when the cotton is offered for sale but not actually sold. These sampling practices have changed little for many decades. During the 1949-50 season it was found that the average bale of United States cotton consumed by domestic mills was sampled about three times (7). 2/ Those that are exported are usually sampled one, two, or three additional times before they are consumed, although generally the extra samples taken after the cotton leaves this country are taken from only one side of the bale.

The conventional method of sampling and the associated trade rules and practices have several defects. A sample cut by hand from a bale often does not provide a reasonable representation of the bale contents, since it is only a small specimen taken from a thin outer section of two sides of the bale. Differences in the internal contents of the bale are not determined until the bale is opened. Also, the portions of cotton drawn from opposite sides of the bale in cut sampling are often of different qualities. In these cases, domestic trading rules are such that the side with the lower quality determines the classification given the entire bale. When this lower side represents only a thin outer layer of the bale, as is often the case, the seller obviously fails to obtain full value for his cotton. Other major defects of the conventional method and frequency of sampling are the mutilated, contaminated, and unsightly condition of the bale surfaces, the added fire hazards, and the loss in value

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1/ Mr. Cooper and Mr. Pritchard are agricultural economists in the Marketing Economics Research Division of Agricultural Marketing Service. Mr. Campbell is an agricultural economist in the Marketing Division of Farmer Cooperative Service.

2/ Underscored numbers in parentheses refer to items in the Literature Cited, p. 35.

of the cotton going into the "city crop" from the sample trimmings and the other cotton removed or otherwise detached from the bale through the sample holes.

With a view to at least partially overcoming the major defects of the historical method of sampling, research workers in the United States Department of Agriculture spent a number of years developing and testing devices for mechanically sampling cotton bales during ginning (4), (2), (6). Commercial manufacture and use of mechanical samplers, based on the designs and specifications developed by the Department, began in 1955. By the end of that year, 22 such samplers and 2 previously constructed Government-owned experimental samplers were in use. All but one of these were in gins in California. The following year, 8 additional samplers produced by 2 manufacturers were installed and 17 more were installed in 1957, bringing the total to 47. By 1959, a third manufacturer was producing and installing mechanical samplers, and other firms were reported to be conducting research on this means of sampling.

The introduction and use of commercially produced and privately owned mechanical samplers attracted considerable attention among domestic producers, ginners, merchants, and others. Some of the industry leaders particularly concerned about the package and surface condition of American cotton and the trend toward more exact quality determination have described mechanical sampling as a highly important development. Since 1956, the Cotton and Cottonseed Research and Marketing Advisory Committee has repeatedly recommended that the Department of Agriculture conduct additional research to help bring about more widespread use of mechanical sampling.

PURPOSE, METHODS, AND LIMITATIONS OF STUDY

This study was designed to provide information which would contribute to improvements in the method of sampling cotton and, in turn, increase marketing efficiency for American cotton and so improve its competitive position. More specifically, this study was made (1) to indicate the advantages, disadvantages, costs, and operating problems of mechanical sampling, and (2) to provide suggestions and other information on the possibilities of and limitations to the wider use of mechanical samplers and mechanically drawn samples.

This study is based largely on primary data secured in 1957, 1958, and 1959, directly from cotton producers, ginners, merchants, cooperative marketing associations, spinners, USDA classers and classing office officials, and manufacturers of the samplers. The information from ginners, buyers, and some of the sampler manufacturers was obtained by personal interview; practically all the rest was obtained by mail questionnaires.

Information was obtained during 1958 and 1959 from each of the commercial sampler manufacturers, from each of the 8 USDA offices which class mechanical samples under the Smith-Doxey program, and from 52 of the Government classers who collectively classed practically all the 1957-58 season's mechanically drawn samples.

Information for the 1957-58 season was obtained also from 16 domestic cotton merchants or other intermediate buyers and 2 cooperative marketing associations, and from 11 spinners. According to reports from ginners and other buyers and handlers, at least some of these intermediate buyers and spinners had experience with mechanically sampled bales or mechanically drawn samples. These reports also indicated that few domestic buyers and spinners not included in the survey were aware of having had such experience in the 1957-58 season.

Personal interview schedules were obtained on mechanical samplers from 29 of the 31 managers of gins equipped with such samplers during the 1957-58 season. Because several of these managers were responsible for 2 or 3 such gins, usually on the same gin yard, they had experience with 45 of the 47 samplers in use that season. Complete schedules were obtained for 31 gins, but information on number of bales ginned and number sampled was obtained for 38.

A mail questionnaire was sent to 259 producers who were selected at random among the customers of the 31 gins with mechanical samplers for which detailed data were obtained. Of these producers, 174 responded, and 153 returned forms which were fully or largely completed.

NATURE, DISTRIBUTION, AND OWNERSHIP OF THE MECHANICAL SAMPLERS

The Samplers and How They Work

The mechanical cotton samplers now in use are based mainly on designs developed by USDA research specialists. The samplers consist basically of three parts: (a) a valve, (b) a conveyor system composed of a duct, condenser, and, in some instances, a booster fan, and (c) a packaging unit composed of devices for pressing the sample and injecting it into a paper container.

The sampler is constructed to be switched on when the gin is started and it begins taking lint as the first bale is ginned. On subsequent bales, the sampler completes the packaging of the previous sample and then automatically starts taking the next sample. At regular intervals, as the lint cotton moves through the gin lint flue or the gin condenser, the sampler valve opens and diverts a small portion of the lint into the sampler conveyor system to provide subsamples as long as the bale is being ginned or until a full-size sample has been withdrawn. Each of the subsamples is accumulated in the condenser and doffed as a bat into the packaging unit, where it is pressed in such a manner that it can later be separated from the other parts of the sample. The number of subsamples--usually 7 to 10--depends upon the settings of the sampler timing devices, the rate of ginning, and the size of bale. When the gin bale press is turned, the packaging unit is automatically set in motion, pressing the entire sample to a set thickness and to about flat bale density, then ejecting it into a paper container.

The mechanical samplers now in commercial use produce original sample packages which are either 18 inches or 27 inches long and either 2 x 5 or 2-1/4 x 5 inches in depth and width. These are usually cut into two or three 9-inch samples. The samples submitted to the Department of Agriculture for classification are identified with the same type of cards used in identifying cut samples. Beginning with the 1960 crop the part of the original sample going to the Government classing office will also have the gin bale number and gin identification preprinted or stamped on the sample wrapper prior to packaging.

All the mechanical samplers now in use are in Smith-Doxey area gins, where samples from all the bales ginned are sent to USDA field offices for Government classification. Consequently, it is standard practice for these mechanically drawn and packaged samples to be cut into two or three parts at the gin and one of the resulting samples sent to the USDA classing offices. The remaining sample or samples are available for the use of the initial buyer of the cotton or his representative. This method of sampling, therefore, not only provides samples which, at least theoretically, are more nearly comparable to the contents of the bale, but eliminates the need for cutting holes in the sides of the bales. However, as indicated elsewhere in this report, cut samples are sometimes obtained even though unused and slightly used mechanically drawn samples are available. As a result, the full potential value of mechanical sampling is not being realized.

Number, Location, and Ownership of Samplers

On December 31, 1959, there were 153 mechanical samplers in U. S. gins (table 1). This compares with 47 at the end of 1957 and with only 24 at the end of 1955. At the end of 1954, there were only two of these samplers in commercial gins and these were both experimental models built and owned by USDA in connection with its sampler research program.

On December 31, 1959, 138 mechanical samplers, or 92 percent of the total, were located in California and Texas; 8 were in Arizona and 2 in New Mexico; Mississippi, Arkansas, and Oklahoma each had 1. Of the 90 samplers in Texas gins as of that date, all but 4 were installed during the preceding 12 months. During the same 12-month period, 12 samplers went into gins in California, 6 in Arizona, and 1 each in Arkansas and Oklahoma.

Of the mechanical samplers in domestic gins on December 31, 1959, 80 percent were owned by the individual, firm, or group owning the gin, and 20 percent were being leased from the sampler manufacturer on a fee basis. Of the total, 110 were in gins owned by producer cooperative associations, a few were in gins owned by firms which also merchandise raw cotton, and the others in gins owned by independent ginners.

Table 1.--Mechanical samplers in active cotton gins during 1955-56, 1957-58, and 1959-60 by States and type of gin ownership, United States 1/

State	1955-56		1957-58		1959-60 2/	
	Cooperative	Other	Cooperative	Other	Cooperative	Other
	Samplers	Samplers	Samplers	Samplers	Samplers	Samplers
Arizona	0	1	0	2	2	10
Arkansas	0	0	0	0	0	1
California	22	0	36	1	48	4
Mississippi	0	0	0	1	0	1
New Mexico	0	0	0	2	0	2
Oklahoma	0	0	0	0	1	0
Texas	0	0	3	1	60	24
United States 3/	0	2	39	8	111	42

1/ Excludes a Government-owned sampler which for a time was in a commercial gin in North Carolina.

2/ Includes samplers in cooperatively owned gins and in other gins which were leased from the manufacturers.

3/ 24 samplers in 1955-56, 43 in 1957-58, and 42 in 1959-60 were 18-inch models. All others produced 27-inch sample packages.

Ginning Volume of Gins With and Without Samplers

As table 2 shows, the gins with mechanical samplers are much larger, in terms of annual volume of ginning, than the average. For example, the 38 gins with mechanical samplers for which ginning data were obtained, ginned an average of about 6,250 bales each during the 1957-58 season compared with an average of 1,714 bales each for all the active gins in the United States that season. In California, where 76 percent of the reporting gins were located, the 1957-58 average volume for the gins in the study was 6,636 bales, and the average for all the State's active gins was 6,380 bales.

The comparatively high installed cost of the mechanical sampling systems largely explains why the samplers are generally in gins with large volumes. Large-volume gins can more readily justify the use of such equipment for a job which for generations was performed with little cost per bale for either equipment or labor.

It is highly significant, therefore, that such a large proportion of gins in the United States normally gin less than 2,000 bales. The gin managers interviewed estimated the minimum volumes necessary to justify installation of the then existing model samplers at 2,000 to 6,000 bales; the estimates averaged about 4,000 bales.

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Table 2.--Cotton bale volume of gins in survey having mechanical samplers and of all active gins, by States, 1957-58

State	Gins in survey		Average volume, all active gins 1/
	Number	Average volume ginned	
	Gins	Bales	Bales
California	29	6,636	6,380
Texas	3	5,633	2,208
Arizona	2	7,370	5,715
New Mexico	2	4,700	3,490
Mississippi	1	1,800	1,285
North Carolina	1	1,965	694
Total or average	38	6,250	2/ 1,714

1/ U. S. Bureau of the Census, Cotton Production in the United States, Crop of 1957.

2/ Average of all active gins in the United States.

MECHANICAL SAMPLER PERFORMANCE

There are two main aspects of mechanical sampler performance which, along with costs, will largely determine the future use of this means of sampling cotton. These are (1) the proportion of the bales ginned from which the sampler fails to secure an acceptable sample, and (2) the degree to which the mechanically drawn samples represent the contents of the bale. Irrespective of how inexpensive mechanical samples might become, their performance in both these respects must be acceptable before they will be used on a continuing basis, even in gins where volume and other conditions are most favorable.

Proportion of Bales Not Sampled

Information obtained from gin managers shows that the mechanical samplers in the gins covered missed 12 percent of the bales during the 1957-58 season. Since most ginners were paid for the mechanical samples, this percentage is based on records believed to be quite accurate as to the number of acceptable mechanical samples taken. The ginning data include only those bales ginned while the sampler was in place and except for sampler failures would have been operating.

Since the mechanical sampler is rather complicated and most workers responsible for its operation received little or no special training or instructions, the newly installed samplers showed the poorest performance record in 1957-58. These samplers missed about 21 percent of the bales they should have sampled, compared with 9 percent for those installed in earlier years. Nearly three-fourths of the samplers installed prior to 1957 missed less than 5 percent of

the bales they should have sampled in 1957-58, while only one-half of those installed in 1957 made as good a record. Conversely, one-tenth of the samplers installed in prior years and two-fifths of those installed in 1957 missed 20 percent or more of the bales.

Little information was obtained on the mechanical and electrical abilities or the attitudes of the gin crew and managers, but these abilities and attitudes may have an important bearing on sampler performance. At one gin, for example, where a large proportion of the bales were missed, the president of the cooperative association owning the gin reported that the gin manager was not interested in the sampler and made little effort to keep it operating. In another instance, where only 0.2 percent of the bales were missed, both the day and the night crews were instructed to advise the owner-manager immediately if anything went wrong with the sampler. At a third gin, where the sampler performance was also exceptionally good, the manager and crew had the reputation of being able to "get much more out of" any new gin equipment than is done at most gins.

When the field survey was made in the spring of 1958, the records of the main sampler manufacturer at that time showed the mercury switches to be the most frequent item of repair. These switches had been changed to relays in nearly all his samplers. The number of these replacements was 3-1/2 times the number of the next most frequently replaced part. No specific information of this nature has been obtained since early 1958, but the indications are that this and other changes in this manufacturer's samplers, along with greater familiarity of the gin crews, may have reduced the number of bales missed by these machines. In the fall of 1959 the two other manufacturers expressed an optimistic view as to the number of mechanical samplers likely to be in use in the United States in 1960 and in 1965. This suggests that their early experiences were at least reasonably satisfactory in this and other respects. More recently they are said to have become much less optimistic about the outlook, at least for 1960.

Representativeness of Mechanically Drawn Samples

Developmental research which led to the initial USDA-owned samplers, and to the designs later made available for commercial use, was directed particularly toward the problem of satisfactorily sampling bales which the Government and the trade refer to as "mixed-quality," "plated," "mixed-packed," and "false-packed" bales.

Two-sided, plated, and mixed-packed bales are generally indicated by the cut samples. However, such samples generally give no indication of the proportion of the bale represented by either of the different qualities. For the false-packed bale, on the other hand, neither the existence nor the extent of the off-quality cotton involved is indicated by the conventional sampling method. It is generally taken for granted that a mechanical sampler which systematically obtains a number of subsamples at more or less regular intervals during the ginning of the bale would overcome a considerable part of these shortcomings of cut sampling. The extent to which this is true, however,

depends upon (1) the number and size of the subsamples actually taken, (2) the parts of the bale from which the subsamples came, and (3) how the subsamples of the mechanical sample compare with the two parts of the cut sample in representing the portions of the bale from which they were extracted.

Number, Size, and Distribution of Mechanically Drawn Subsamples

Information is available relating to the number and distribution of the subsamples drawn by 35 mechanical samplers from 4 to 20 bales each during the 1959-60 season. Of the samplers checked, about 54 percent gave samples which had an average of from 7 to 10 subsamples, 43 percent gave, on the average, less than 7 subsamples per sample, and 3 percent of the machines averaged more than 10 subsamples (3). For the individual bales checked, the interval between the time the bale press was turned and the sampling valve first opened ranged from 23 to 171 seconds. This interval was 30 seconds or less for 12 percent of the bales, 31 to 45 seconds for 59 percent, and 46 seconds or longer for 29 percent of them. It was reported that at the time the checks were made, four of these samplers were failing to obtain a subsample during the first 60 seconds of ginning time, in each bale, but that these failures were due to the malfunctioning of the sampler's pressing unit.

In most of the gins with mechanical samplers, there is generally little or no interruption in the ginning rate at the time the bale press is turned. Consequently, the time intervals indicated above, together with the rate of ginning, largely determines the amount of cotton going into the bale before the first subsample is taken. During the 1957-58 and 1959-60 seasons, 91 percent of the mechanically sampled bales checked were ginned in 6 to 10 minutes, 1 percent in less than 6 minutes, and 8 percent in more than 10 minutes. The average weight of these bales was about 472 pounds net. These data indicate that with a 30-second or shorter interval before the first subsample is taken, roughly 24 to 40 pounds of the bottom side of such bales would not be sampled. A 45-second interval at ginning rates of 6 to 10 minutes per bale and average size bales would account for approximately 36 to 60 pounds. These amounts of cotton are equivalent to about 2 to over 5 inches in the depth of an average flat gin-pressed bale and about 1-1/2 to a little under 4 inches for the average extra-density gin-pressed bale.

In the fall of 1959 only 12 out of the 35 samplers were regularly obtaining a subsample during the last 60 seconds of ginning time on each bale (3). Nine of them were failing to obtain subsamples from 40 percent or more of the last part of the bale ginned. This was a considerably larger proportion of the bales than in the case of those not sampled in the first 60 seconds of ginning. One reason for this is the fact that some of the samplers were set to get a full-size sample from the smaller bales and, as a result, obtained no subsamples from the last part of the large bales.

In this connection, it is significant to note that of the 788 bales checked in 1957-58 and 1959-60, at gins with automatic samplers, the range in gross weight varied from 300 to 648 pounds, including about 20 to 22 pounds of bagging

and ties. Approximately 2 percent of these bales were 400 pounds and less and 1 percent were over 600 pounds gross weight. According to a beltwide study of gin bale weights for the 1953-54 season, the bales ginned in the three States where practically all the mechanical samplers are now located, which weighed either less than 401 pounds or more than 600 pounds, represented approximately the following percentages of the total: California 3, Arizona 2, and Texas 6 (10). The percentages which were 401 pounds and less ranged from less than one-half to 2 and those which were over 600 pounds varied from 2 to 4. In each of these States, industry trading rules are such that all bales which are approximately 435 pounds or less are subject to penalties as are all Texas bales 650 pounds and above and all California and Arizona bales weighing more than 700 pounds.

There is little doubt that unusually light or unusually heavy bales, which are at least occasionally received at most gins, create a significant problem in mechanical sampling. This is particularly true since there are now Government regulations or specifications requiring that mechanically drawn samples include a minimum of seven subsamples with one of these being taken during the first 60 seconds and one during the last 60 seconds the bale is being ginned. The regulations also specify that the samples weigh at least 6 ounces and be at least 8 inches long and not exceed 10 inches.

The 402 18-inch sample packages which were weighed in 1957-58 averaged 15.3 ounces gross weight and 14.7 ounces net. Approximately 8 percent of these were 12 ounces or less in gross weight and not adequate to provide two full samples of 6 ounces net weight. However, even when the total package was 12.6 ounces gross and heavier, it did not necessarily mean that it would be divided into two samples, both of which met the minimum weight requirement. Of the 506 individual samples for which weights were obtained at the gins, 11 percent were 6 ounces or less in gross weight and approximately 5.7 ounces or less net weight. For 253 of these samples going to the USDA classing offices, 7 percent weighed less than 6 ounces net. Of the remaining 253 samples that were available for the use of buyers and cooperative marketing associations, 16 percent weighed less than 6 ounces, excluding the wrapper weight. It is generally agreed that except possibly for unusually small bales, most, if not all, of these underweight samples can be eliminated by properly adjusting the sampling valves and by exercising reasonable care in cutting the sample packages.

It is reported that following the issuance of the USDA sampler regulations in October 1959, rather prompt adjustments were made in many, if not all, the samplers known not to be meeting these specifications. Inspection procedures have been developed to help insure that a large proportion of the mechanically drawn samples of the 1960 crop would meet the Government specifications.

Even if mechanical samplers meet the existing Government specifications, they still will not fully meet the sampling problems for mixed-quality bales. For example, where the outer portion of the two-sided bale is composed entirely of cotton going into the gin press box during the first or last 45 seconds the bale is being ginned, the mechanically drawn samples may not give any indication that it is a mixed-quality bale. Also, it is possible for the deliberately false-packed bales to be falsely sampled with the mechanical sampler. Such

sampling, however, could only be done by or with the knowledge of one or more members of the gin crew. For the most part the same would be true of false-packed bales, although some bales of this type could be made without the gin crew noticing them or knowing whether or not they resulted from a deliberate effort on the part of the grower.

A recently released Agricultural Marketing Service research report indicates that in the 1954-55 season an estimated 3.4 percent of the U. S. crop consisted of mixed-quality bales, with the percentage in some districts averaging about 10 percent (8). In that report such bales were defined as those of which the two parts of the cut sample (one part from each side of the bale) differed by one grade or more, one or more colors, or 1/16 inch or more in staple length. While no information is available on the thickness of the plates involved, it seems likely that a considerable proportion of such bales would not be indicated by samples taken by the existing mechanical samplers.

Mechanically-Drawn Samples Compared with Cut Samples

Because of the variation in the quality of cotton within individual bales and the conventional method of determining the grade and staple length of a given sample of cotton, it is difficult to obtain accurate measures of exactly how good mechanically drawn samples are. To minimize the normal variations in grade and staple designations for individual bales, a considerable number of bales are needed in studies comparing the two types of samples. But even then there is the question of the actual differences in the portions of the bale from which the two types of samples were taken, as well as how well the samples represent those portions of the bale.

A number of checks are said to have been made several years ago which showed that the samples drawn by the latest laboratory model experimental samplers were quite satisfactory. In 1954-55 some checks were made by the Department on the Government-owned experimental samplers in commercial use that season in California and Arizona. These comparisons were particularly concerned with the grade, staple length, and trash content of samples drawn both mechanically and by hand at intervals during the ginning of the bale, compared with conventional cut samples. They also included efforts to determine the extent to which the differences might be explained by the sampler performance or by quality admixtures within the bales as indicated by differences in the two sides of the cut samples and in the individual segments of the mechanical samples, as determined by the classers. These checks indicated that, in general, these two experimental samplers were doing a good job.

Since the commercially produced and owned samplers have gone into use, a number of checks apparently have been made by some of those most directly concerned. One of these, the results of which were supplied by one of the cooperating ginners, involved a comparison of the grade and staple length of 313 mechanically drawn samples with 290 cut samples, as classified by Government classers under the Smith-Doxey program. Each mechanical and each cut sample came from different but adjacent bales in 222 separate lots of seed cotton ginned at a single gin in California during the 1955-56 season. Approximately half the

samples of each type came from bales which were machine picked and half from those that were hand picked. Table 3 shows that the mechanical samples averaged slightly higher than the cut samples in grade, but slightly shorter in staple length. This was true both for the hand picked and the machine picked cotton.

Table 3.--Average grade index and average staple length of mechanical and cut samples from different but adjacent bales from same lots of seed cotton, 1955-56 crop 1/

Method of harvest, number of lots, and kind of samples taken	Number of bales	Average grade index	Average staple length
Hand picked, 104 lots:			
Mechanical samples	154	103.3	34.3
Cut samples	151	103.1	34.5
Machine picked, 118 lots:			
Mechanical samples	159	97.9	34.0
Cut samples	139	97.6	34.1

1/ Data were obtained from a single gin in California that used a mechanical sampler. A lot, as used here, refers to a group of bales ginned one after another for a given grower. Classification on the first bale was omitted to avoid influence of preceding lot if any. Only lots in which one or more bales besides the first were sampled by cutting and one or more were sampled mechanically were included in averages of grade indexes and staple lengths. And only the grade indexes and staple lengths of samples cut from bales next to bales sampled mechanically or vice versa were included.

Unpublished data resulting from a more recent check, where mechanical and cut samples from the same bales were compared, indicated similar slight differences.

Of the cotton producers and the gin managers contacted as a part of this study, 9 out of 10 in each group expressed the view that mechanically drawn samples represent the contents of the average bale better than cut samples. More than 8 out of 10 of the Government cotton classers who had classed mechanically drawn samples felt that such samples were either better than or equal to cut samples. Nearly one-half of those contacted who represented domestic cotton merchandising firms indicated that the cotton classers in their firms did not like mechanical samples. In almost one-third of these firms the classers were reported as having expressed the view that these samples generally give a somewhat lower overall class outturn than cut samples do. All four of the responding spinners who had recognized experience with mechanical samples, reported the two types of samples equally representative of the bale contents. However, except for the spinners, 3 of which reported that class outturns had been checked with both types of samples, it is believed that most of the respondents based their views on general impressions of their own or of others rather than on actual checks of the two types of samples.

Nearly 40 percent of the 52 Government classers reporting indicated one or more defects they believed the mechanical samples had, even though more than 80 percent of them felt these samples were more representative of the contents of the bale. By far the most frequently mentioned defect was the compression or density of the mechanical samples, but it is significant that although six of these classers thought they were not compressed enough, three indicated the samples were too dense, as did some of the merchant representatives. Five of the Government classers reporting said these samples were too dry and that this caused the "pull" (in determining staple length) to snap off. Some of the Government classers, like some of the merchants' classers, felt the mechanical samples tended to be low in grade and short in staple length.

Some of the few classers personally interviewed expressed the view that often cotton classers, like many other workers, had a certain amount of dislike for new procedures or conditions unfamiliar to them, but that after becoming familiar with the new situation, they frequently preferred it over the old. An example cited was the change made some years ago from the use of natural to artificial light in the classing rooms. An officer in charge of one of the Government classing offices indicated he found some of the classers, after classing mechanical samples for a time, preferred to class them rather than the cut samples. However, at the time the Government classers completed their mail questionnaire in the summer of 1958, between 42 and 58 percent of them thought the cut samples were best in such characteristics as length, width, and appearance for determining grade, "feel" in determining staple length, and time required for classing.

A large proportion of the hundreds of thousands of bales mechanically sampled up through 1958-59 have been marketed through two cooperative marketing associations. Much of this cotton has been marketed to numerous mills in this and in foreign countries entirely on the basis of mechanically drawn samples. Presumably these associations, through their own records and their contacts with the mills, have the most reliable information available as to the usefulness of mechanical samples compared with cut samples, and the overall advantages and disadvantages of the two methods of sampling. High officials in the associations have not only indicated that they are pleased with mechanical sampling, but are recommending it to others marketing their cotton through these associations. It seems highly significant, in this respect, that in 1959-60 approximately 105 farmer-owned cooperative gins with overlapping memberships in the two marketing associations installed mechanical samplers, an increase in such gins of 150 percent over 1958-59.

COSTS OF MECHANICAL SAMPLING

Gin owners thinking of installing a mechanical cotton sampler are concerned not only with the sampler's performance but also with the costs of sampling cotton bales in this manner compared with cut sampling. Now that such samplers can be rented as well as purchased, gin owners should consider the comparative costs of the two methods of acquiring and using such a sampling system and how they each relate to the costs of cut sampling. The information in this and the following section is designed to aid gin owners in connection with these considerations.

It may be logically assumed that there is little or no difference in the variable expenses to ginners of samplers which are owned and those which are rented, except for normal repairs and maintenance. The important considerations, therefore, in determining whether to purchase or rent a mechanical sampler are how the rental fees per bale and per season, which include normal repairs and maintenance, compare with the fixed expenses of owning the same or a comparable sampler. In view of this, and since the rental fees are readily available from the sampler manufacturer, the more important estimates needed for comparing the two methods of acquiring the use of mechanical samplers are those relating to fixed expenses of the sampler which is owned. But for comparing costs of mechanical sampling with those of cut sampling, estimates are needed for both fixed and variable costs. All the estimates are exclusive of the value of the cotton in the samples and of supervisory and overhead costs on the assumption that these would not be appreciably affected by the method of sampling.

Adapting Survey Data to a Model Analysis

The information on costs of mechanical sampling collected from the different gins varied widely with location, conditions, and practices, terms of sale, size, and make of samplers, distance from place where sampler was manufactured, and date of purchase. A modified type of model plant analysis was used, therefore, to eliminate or minimize variations in the installed costs (price of sampler and all accessories, plus cost of installation) and operating expenses of the samplers surveyed. This involves certain assumptions and the use of actual or adjusted averages relating to these variable factors.

The specific operation assumed for this analysis consisted of an 18-inch mechanical sampler, installed in the San Joaquin Valley of California in 1958, and operated at wage rates prevailing that year. The average cost of samplers as delivered and installed was estimated from available survey data and used along with costs for other equipment in computing the total cost. The average amount of labor used per bale on mechanical samplers, as computed from the gin survey, was used with a rate of $2 per hour for labor cost. Volumes ginned were assumed to differ by 1,000-bale intervals from 4,000 to 9,000 bales, in order to examine effects of volumes on fixed costs. The most common rate of depreciation reported in the gin survey was used. Tax and insurance rates were adopted from another study that included rates paid by California gins (1).

Installed Cost of Model Mechanical Sampling Systems

The total cost of a mechanical sampling outfit includes (1) cost of sampler, including freight and installation; (2) cost of other equipment necessary for operation of sampler, such as air compressors, wiring, and pipes, and installation costs; and (3) auxiliary equipment generally used, such as sample storage space, and a sample table or desk.

The average installed cost of a mechanical sampler unit in the San Joaquin Valley of California, making 18-inch sample packages, was estimated to have been $4,825 in 1958 on the basis of data obtained from ginners and sampler manufacturers (table 4).

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Table 4.--Estimated costs of model mechanical cotton samplers installed in San Joaquin Valley of California in 1958

Items of cost	Amount	Percent of total
	Dollars	Percent
Mechanical sampler 1/	4,825	87
State sales tax	135	2
Air compressor	500	9
Storage space and sample desk	100	2
Total	5,560	100

1/ Includes price of sampler with 18-inch packaging unit, and costs of standard lint flue connections, freight, and installation of sampler.

The sales tax in California amounted to $135 at 3 percent of a sampler price of $4,500, excluding freight and installation costs.

Most ginners had put in a larger air compressor than required for their mechanical samplers and used air from their compressor for sampler and also for other purposes such as operating lint pushers on bale presses or cleaning gin machinery and gin buildings. Air compressors large enough to handle samplers alone could be obtained and installed for about $500, including wiring, sales tax, and installation labor. Consequently, an estimate of that amount was used for the air compressor cost.

Storage facilities were constructed at gins for the mechanical samples that were stored at gins for various lengths of time. A sample table or desk was usually used for cutting sample packages into two samples. The average of costs reported for storage facilities and desk or table was about $100.

The total estimated cost for a complete mechanical sampler outfit installed in the San Joaquin Valley of California in 1958, including air compressor, sample storage facilities, sample table or desk, and sales tax, was $5,560. The installed sampler accounted for 87 percent of this total.

Operating Expenses for 18-inch Sampler System

Operating expenses, as used in this report, include both fixed and variable expenses but do not include overhead costs of management, supervision, or buildings. Fixed expenses include depreciation, insurance, taxes, and interest on investment, which remain the same regardless of volume. Items of expense that varied with volume sampled are classed as variable expenses and include labor, repairs and maintenance, sample wrappers, and electric power.

Fixed Expenses

On the basis of the installed cost of mechanical samplers in table 3, the annual depreciation on samplers computed on 10 years of life or 10 percent amounted to $556 when rounded (table 5). Ginners expected shorter life for samplers than for gin machinery in general, and 10 years was the most frequent estimate on length of life for such equipment.

Table 5.--Estimated fixed annual expenses for a model mechanical cotton sampler installed in San Joaquin Valley, Calif., 1958

Source of expense	Amount	Percent of total
	Dollars	Percent
Depreciation (10 percent)	556	70
Insurance 1/	13	2
Taxes 2/	79	10
Interest 3/	139	18
Total	787	100

1/ Based on average rate of 26.7 cents per $100 on 90 percent of installed cost.
2/ Based on a rate of $1.42 per $100 of installed cost.
3/ Calculated on basis of 5 percent of one-half of installed cost.

Interest on investment is included as a fixed expense in recognition of the increased investment required for installing a sampler. The average annual investment in a sampler for its life would be one-half of the original cost. Consequently, one-half of the installed cost of $5,560 at a 5 percent interest rate was used to determine the interest expense of $139.

Estimates of the annual cost of the four items of fixed expense for a mechanical sampling system totaled $787. About 70 percent of these costs are accounted for by depreciation, and 18 percent by interest.

Since these fixed costs exist, no matter how many or how few bales are sampled, costs of these items per bale vary in direct proportion to the number of bales ginned and sampled. It is highly important, therefore, that these costs be examined on a per bale basis.

In view of the bales missed by the samplers surveyed, it was assumed in this analysis that the model sampler missed 10 percent of the bales ginned. If 5 percent of the bales were missed, the total fixed expenses per bale sampled given in table 6 would have been reduced 1.1 cents on the 4,000-bale volume ginned and 0.6 cent per bale on the 9,000-bale volume. If more than 10 percent of the bales were missed, the fixed expenses would increase accordingly.

The total fixed expenses per bale sampled, as computed in this manner, ranged from 21.9 cents at the 3,600-bale level to 9.7 cents at the 8,100-bale level. These fixed expenses per bale were half as much per bale on the 7,200 bales sampled from 8,000 ginned as on 3,600 sampled from 4,000 ginned. These expenses would have averaged 43.9 cents per bale on 1,800 bales sampled out of 2,000 bales ginned and 87.8 cents on 900 bales sampled out of 1,000 bales ginned.

Table 6.--Estimated fixed expenses per bale sampled by a model mechanical cotton sampler installed in San Joaquin Valley, Calif., by volume ginned, 1958

Bales ginned	Bales automatically sampled 1/	Expense per bale sampled				
		Depreciation	Insurance	Taxes	Interest	Total
	Bales	Cents	Cents	Cents	Cents	Cents
4,000...	3,600	15.4	0.4	2.2	3.9	21.9
5,000...	4,500	12.3	0.3	1.8	3.1	17.5
6,000...	5,400	10.3	0.2	1.5	2.6	14.6
7,000...	6,300	8.8	0.2	1.3	2.2	12.5
8,000...	7,200	7.7	0.2	1.1	1.9	10.9
9,000...	8,100	6.7	0.2	1.0	1.7	9.7

1/ Assuming 90 percent of bales ginned are sampled.

Variable Expenses

The labor used per bale in mechanical sampling frequently differed widely between individual gins ginning about the same volume, but tended to average about the same irrespective of volumes. The amount of labor used per bale appeared to vary with managers' decisions, skill of workers, gin arrangement and equipment, and other factors, rather than volumes sampled. For the most part the relations of costs per bale for repairs and maintenance to volumes were covered up by service contract expenses or other factors.

The cost of sample wrappers per bale was treated as a constant. Prices of wrappers differed between areas, by weight of paper used, and by whether or not wrappers were numbered to match bale numbers. A given kind of wrapper, however, was apparently sold at a constant price per 1,000 in a given area, regardless of number per sale.

Power expense per bale was a minor item of expense on the samplers surveyed at any volume. The power for a given sampler would cost somewhat less per bale for large volumes than for small volumes, but the difference would probably be only a fraction of a cent per bale at most volumes. For that reason, and because of the absence of more complete information, power expense on samplers was assumed to have been a constant amount per bale.

The labor on samplers and samples included in the study was calculated from observations made at the gins during the visits in the fall and from the labor reported for the season by gin managers. The amount of such labor is estimated to have been approximately half of one man's time, on the average, although this varied widely by gins. Observed time ranged from 1.2 to 7.2 man-minutes per bale, and time reported by gin managers ranged from 1.6 to 9.2 man-minutes per bale. The observed time included only the time while the gin was operating and the observations were made in a busy part of the season. The average time of 5.5 man-minutes, as computed from the gin managers' reports for the entire season, which included lost and idle time, was used in this analysis to figure labor costs per bale.

Expenses for labor used in California samplers in 1957-58, including employers' payments on social security and insurance on workers, averaged $1.93 per hour. Wage rates were up slightly in 1958, so $2 per hour was used. At that rate per hour, 5.5 minutes of labor costs 18.3 cents per bale (table 7).

Table 7.--Estimated variable expenses per bale sampled for a model mechanical cotton sampler installed in San Joaquin Valley, Calif., 1958

Item of expense	Amount per bale	Percent of total
	Cents	Percent
Labor	18.3	79
Repair and maintenance	3.0	13
Sample wrappers	1.3	6
Power	0.4	2
Total	23.0	100

Repairs and maintenance averaged $183 per sampler on 19 samplers on which data were available for 1957-58. Five of the 19 were purchased in 1957. A service contract for that season was included in the terms of the purchase contract by one firm. The charge made for similar service contracts was deducted from purchase prices and included in repair and maintenance costs as calculated in this report. Service contracts were reported for 1957 on five of the other samplers installed before the 1957 season. The amounts paid for those service contracts were also included in repair and maintenance expenses. Other outside labor and parts were included as part of repair and maintenance expenses but gin crew labor used on repairing samplers was not included. These combined repair and maintenance expenses averaged 3.0 cents per bale sampled by the 19 samplers reporting. The average number of bales sampled by those samplers in 1957-58 was 6,130.

Sample wrapper prices reported by the survey gins averaged $11.89 per 1,000 with prices ranging from $8 to $15. A few wrappers were lost from splitting and other causes. Since $13 per 1,000 was the most common price and to provide an allowance for splitting and other losses and a possible increase in 1958 prices, 1.3 cents per bale sampled was used as wrapper expense in table 7.

A 1-1/2 horsepower air compressor motor running steady was reported to furnish adequate air for operation of mechanical samplers. A 1/3 horsepower motor was used to operate some sampler condensers and doffing rolls. A 1/4 horsepower motor was used to run booster fans. Also, electricity was used to operate the valve control mechanism on some samplers. Consequently, a total of about 2-1/4 horsepower or 1.7 kilowatt hours were estimated to have been used per hour in operating the samplers. The average ginning time per bale for the gins surveyed was about 10 minutes and 1.5 cents per kilowatt hour was the approximate average charge paid by ginners for electricity in San Joaquin Valley of California (1).

On the basis of 1.7 kilowatt hours per 6 bales and a rate of 1.5 cents per kilowatt, the estimated sampler power expense was about 2.5 cents per hour or about 0.4 cent per bale. In some other States, the amount of power would have cost over twice as much. However, 1.0 cent per bale would likely cover the power expense for automatic samplers in the highest cost areas.

The variable expenses as developed above totaled 23.0 cents per bale sampled. Labor was 79 percent of the total, and the major item of variable expense.

Total Expenses

The estimated fixed and variable expenses per bale sampled have been combined to indicate the total expenses expected for owning and operating a mechanical sampler in 1958 in California. Variable expenses were treated as constant amounts per bale at the volume range of 4,000 to 9,000 bales ginned and 3,600 to 8,100 bales sampled. The fixed expenses were included (in table 8) just as carried in table 6.

Total expenses per bale sampled ranged from 44.9 cents, when 3,600 bales were sampled, to 32.8 cents per bale when 8,100 bales were sampled. Since the sample package from each bale may be cut into two samples, the comparable costs per sample ranged from 22.5 cents to 16.4 cents.

Increases in volumes above those included in table 7 would reduce total operating expenses slowly. For example, on 11,700 bales sampled out of 13,000 ginned, the estimated operating expenses would total 29.7 cents per bale sampled On the other hand, these expenses would total 66.7 cents on 1,800 bales out of 2,000 ginned and 110.4 cents on 900 bales sampled from 1,000 bales ginned. On an estimated 2,700 bales sampled out of 3,000 ginned, a volume considerably above the 1957-58 average for all active gins in the U. S., the total estimated operating expenses would be 52 cents per bale sampled or 26 cents per sample, assuming sample packages from all the bales sampled were of adequate weight and properly cut into two acceptable samples.

Table 8.--Estimated operating expense per bale sampled and per sample at selected volumes ginned, model mechanical cotton sampler installed in San Joaquin Valley, Calif., 1958

Bales ginned	Bales automatically sampled	Fixed expense per bale	Variable expenses per bale	Total operating expenses	
				Per bale	Per sample
	Bales	Cents	Cents	Cents	Cents
4,000.....	3,600	21.9	23.0	44.9	22.5
5,000.....	4,500	17.5	23.0	40.5	20.3
6,000.....	5,400	14.6	23.0	37.6	18.8
7,000.....	6,300	12.5	23.0	35.5	17.8
8,000.....	7,200	10.9	23.0	33.9	17.0
9,000.....	8,100	9.7	23.0	32.7	16.4

Where the farmers own the gin it is clear that, except under unusual circumstances, all such sampling costs are borne by the producer. While it may be more difficult to determine, it is reasonable to expect that over a period of time the same thing is true where the farmers are patronizing independent gins.

Costs for 27-inch Sampler System

Mechanical sampling units which make sample packages that are about 27 inches long have been in use since the 1957 ginning season. Very little information was obtained on them, however, either in the 1957-58 survey or since then.

The available data on sampler prices and estimated additional costs for other equipment indicate the larger sampler system in use in 1958 would cost about $500 more than the 18-inch system. In terms of fixed annual expenses, these higher costs would be equivalent to about $71, or 0.9 cent per bale sampled when the volume is 8,100 per season and about 2 cents at the 3,600 bale volume. Wrapper cost was estimated at about 0.6 cent more per bale and power cost at 0.4 cent more per bale. Repairs and maintenance costs were estimated at roughly 1 cent per bale more than for the smaller system. The extra labor cost is estimated at roughly 1 cent more per bale, to allow for an extra fraction of a minute to cut the third sample for some of the bales. These samplers, therefore, appear to be making three-sample packages for something like 3.9 to 5.0 cents more per bale sampled than samplers which turn out the 18-inch two-sample package. This means that the estimated expenses incurred by the gin owner for each available sample are, roughly, one-fourth less than those given in table 8.

The extent to which the second and third samples are used is not known. The most common current practice, however, is for about one-third of the

original package to be sent to the Government classing office and for the remaining double sample package to go from the gin to the warehouse or elsewhere for use if and when needed. In some instances, one or both of the available samples may go directly into the "city crop" and a cut sample may be obtained the next time a sample is needed. Where the extra samples are not used, there is a needless loss in the weight of the bales and a reduction in the value of the cotton going into the unused samples. Even so, however, this economic loss is less than that which often results either from trimming a single cut sample or from the extra unused "just-in-case" samples cut at some warehouses before the bales go into storage.

Some of the 27-inch samplers are now being leased on a 5-year basis for a rental fee of 35 cents per bale, with a minimum annual rental of $1,050. The rental fees cover all fixed expenses except for an initial installation charge of $250. For gins with the volume ranges given in table 8, fixed expenses for leased samplers would be 35 cents per bale plus a pro rata share of the installation charge. With installation charges computed on a 10-year basis as was done with similar expenses for the purchased samplers, estimated installation cost would amount to less than 1 cent per bale on volumes over 2,500 bales. As already indicated, the estimated variable expenses per bale would be about the same as if the sampler were owned except for the usual repair and maintenance costs.

The combined fixed and variable expenses per bale or per sample, as estimated in this analysis, are considerably greater for the ginner operating under a lease or rental arrangement than for one who owns the same size sampler. This does not necessarily mean, however, that the gin owners who purchased samplers have made a better deal than those who are renting. The individual gin owner needs to consider several factors in deciding whether to rent or buy. The most important of these are:

1. How well a particular sampler is likely to function in terms of both (a) proportion of bales ginned from which acceptable mechanical samples are obtained, and (b) repair and maintenance costs.

2. Whether or not developments relating to mechanical samplers and to the acceptability of mechanical samples might make it especially desirable for the gin to either (a) change to a new model in less than 10 years, or (b) go back to the conventional method of sampling.

3. The nature of the financial arrangement the ginner may be able to work out in the event he decides to either change samplers or discontinue mechanical sampling within less than 10 years.

These and other considerations, including the amount of capital involved in purchasing rather than renting, might cause many individual ginners to prefer renting.

COSTS OF CUT SAMPLING AND RELATED ECONOMIC CONSIDERATIONS

The members of cooperative gins, producers with their own gins, and managers of such gins, who are contemplating the installation of mechanical samplers are especially interested in both (1) the direct costs or expenses of obtaining and handling cut samples in comparison with mechanical samples, and (2) the comparative amount and value of the cotton removed from the bale under the two sampling procedures, whether this cotton is removed before or after the farmers' sales weights have been determined, and who gets the loose cotton resulting from cut sampling. The independent ginners are interested in the comparative costs and in the amount of fee, if any, charged for mechanical samples. Farmers, ginners, and others in the industry are also interested in the extent to which cut sampling and mechanical sampling may affect (1) the condition of U. S. bales and the costs of moving them through marketing channels to domestic and foreign mills, and (2) the practices, costs, and the source of purchases of these mills. This section is designed to provide at least some additional information relating to each of these.

Direct Cost of Cut Sampling to Ginners and Farmers

A very large proportion of the U. S. crop is still sampled by cutting through the bale covers and into the surface of two sides of the bale and pulling varying amounts of cotton from each of these holes. Practically all the initial cut samples taken from these bales, especially in Smith-Doxey production areas, are obtained by (1) employees of the gins, (2) commercial samplers who perform this operation as a service, or (3) employees of warehouses located within a few miles of the gins.

To the independent ginner whose employees cut the initial sample or samples, his direct costs or expenses, which in some respects at least are comparable to the expenses included in the preceding section on mechanical sampling, are determined by the costs of the labor, equipment, and supplies involved minus the value of any resulting loose cotton which may become his. The farmer who patronizes such a gin and who sells on gin weights taken prior to sampling is interested in these same net costs to the extent that they affect the ginner's charges. Where the bales are sampled at the gin but the initial sale of the cotton is on warehouse weights, the farmer also has a direct interest in the reduced value of his bale due to the weight of the loose cotton which he otherwise would have sold as a part of his bale. Where the gin is owned cooperatively by the farmers and the sampling is done at the gin, the owners and the manager are interested in both the cost of obtaining the samples and the reduced value of the bale, if any, due to the loose cotton.

In view of the limited amount of equipment and supplies involved, labor is generally the most costly item in cut sampling from the standpoint of both gins and warehouses. Two gin managers interviewed in connection with the automatic sampler survey estimated that the actual time required by their pressmen for sampling bales before installation of automatic samplers averaged about 2 minutes per bale. That time included insertion of class cards in samples, and rolling and sacking samples.

One inexperienced man who was working on an automatic sampler included in the survey cut samples from bales missed by the automatic sampler. It was observed that he cut a sample in 1 minute and 10 seconds. Additional time was required to insert class card and to roll and sack the sample, which brought the total close to 2 minutes. At a gin observed by USDA researchers in the fall of 1956 while working on the bale press study (2) an experienced worker was observed cutting samples with a power saw instead of a knife. He cut the sample, inserted the card, and rolled and sacked the sample in less than 1 minute on the average.

In a 1958 USDA marketing research report estimates were given on the amount of time required for cut sampling as a part of an efficiently organized, specialized phase of the handling of bales in public warehouses (9). These estimates indicated the amount of labor for cutting, pulling, trimming, and wrapping samples under those conditions averaged about 1 minute per bale and per sample.

These observations both at gins and at warehouses, like those for mechanica sampling, only included the time while the workmen were busy and did not include any allowance for lost and idle time. These averages, therefore, are similar to the average of 3.9 minutes for the observations on automatic samplers reported in the section on mechanical sampling costs. A lower percentage of labor is probably lost at the warehouse during a season than at gins, however, on account of a greater volume of cotton to be sampled, more diversity of work at warehouses (which are generally also compresses), and greater flexibility in the use of laborers.

If 2 minutes per bale for cut sampling at the gin is considered comparable to the time observed for mechanical sampling (or 70 percent of the total reported time charged for sampling including allowances for lost and idle time) then the estimated time of gin pressmen for cutting a sample would be 2.9 minutes and cost approximately 9.6 cents where labor costs $2 per hour. If the observed time for cutting samples at warehouses is, for reasons indicated above, considered to be 80 instead of 70 percent of the total, the estimates for cut sampling at warehouses would total 1.25 minutes and cost 4.1 cents.

The equipment and supplies normally used in the conventional method of sampling include a sample knife, whetstone, and a few sample sacks each of which will hold about 30 samples. All of these can be bought for $5 to $7 or less, depending upon the quality of the items and the number of sample sacks used over a period of days. Except for accidents and losses, these items could easily be used for at least 1,000 bales and some items, with reasonable care, for many thousands of bales. The cost of such equipment is, therefore, only a fraction of a cent per bale and per sample.

The amount of loose cotton resulting from cutting samples, according to eight ginners furnishing such estimates as a part of the sampler survey, ranged from less than 1/2 pound to over 1-1/2 pounds per sample. Practices and customs followed and the relationship of owners of cotton and those cutting samples, as well as the skill of the samplers, largely determine the amount of loose cotton.

Apparently the original value of cotton is reduced 10 to 40 percent when removed from bales in sampling, depending partly on how carefully the loose cotton is handled.

Gins and warehouses frequently get the loose cotton from sample trimmings and sample hole pickings. Many of the commercial sampling firms in California charged a fee of 5 cents per bale for one sample with the sampling firm getting all the resulting loose cotton. Other commercial samplers charged 25 cents per bale with the gins getting all the resulting loose cotton. Others charged an intermediate fee of about 10 or 15 cents plus half of the receipts from the loose. Little specific information is available as to the amount of loose obtained by commercial samplers or by warehouses, but some farmers and ginners indicated that the amount was greater than that usually taken by the gin crews.

The limited information available and the wide variations in the amount and value of loose made it difficult to estimate an average for this aspect of cut sampling. Consequently, this phase of the analysis is also limited to assumed situations under conditions existing in California in 1958.

An example of a low-cost situation is where the pressmen at a gin owned by an individual farmer or a group of farmers cut the samples and obtain 1/2 pound of loose per bale in sampling, all of which goes to the farmer or farmers. The loose is assumed to be carefully handled and to bring 20 percent (or 7 cents) less per pound than the original value of 35 cents. The reduction in value of loose from cutting a sample would be 3.5 cents. This, plus an assumed labor cost of 9.6 cents and equipment costs of, say 0.2 cent, makes a total cost of 13.3 cents for a cut sample. If the cost of labor is omitted, on the basis that the pressmen would otherwise be idle at the time the sample was cut, trimmed, and tagged, the cost would be 3.7 cents per sample and per bale. None of these costs include the value of the cotton making up the trimmed sample.

An example of high costs to farmers at cooperative or other farmer-owned gins is where a commercial sampler charges 5 cents per bale and takes an average of 1-1/2 pounds of loose per bale. In this case, and at 35 cents per pound for cotton, the producers' total cost would be 57.5 cents.

The costs to farmers for cut samples at commercial gins depend upon the specific practices followed. In some cases, where the cotton is sold on warehouse weights and 1-1/2 pounds or more of loose are removed in sampling at the gin, the producers' direct cost may equal or exceed the 57.5 cents indicated above. On the other hand, farmers may have no direct or recognizable cost if they sell their cotton on gin weights made prior to sampling at the warehouse and if the buyer pays the same price for gin weight as for warehouse weight bales. In this case sampling is included as an unspecified part of the warehouse receiving charge. The cost to the warehouse of taking and handling such samples might easily be covered by the returns received from the loose cotton obtained.

Other Considerations Relating to Cut Sampling Compared with Mechanical Sampling

Cut sampling and the number of times the average bale is sampled have contributed greatly to the criticisms that have long been made of the American cotton bale package. The surface contamination of these bales, weather damage, fire losses, and need for picking sample holes and for picking cotton from the sample cuts in the bagging after the bagging is removed from the bale, the extra time in handling bales with ragged bagging, together with the unattractive appearance of the bales, have often been said to be responsible for sizable economic losses in marketing channels. Because of these defects, all of which are at least partially due to sampling methods and practices, and because of other shortcomings of U. S. cotton bales, the domestic cotton industry and USDA have given considerable attention to the matter in the last few years. Some of the effort involved has been devoted to studies of the costs resulting from these shortcomings.

In a research report released in 1958, the Agricultural Marketing Service estimated that in 1956 domestic mills incurred preprocessing costs attributable to the shortcomings of the bale package which were equivalent to 33.2 cents per bale consumed (5). For the 51 percent of the bales the surfaces of which were cleaned before processing, these estimated costs averaged 45.6 cents per bale. While no separate estimates were made there is no question but that a significant part of these costs are due to cut sampling practices.

A more recent, similar study covering the most important foreign markets for U. S. cotton included estimates for foreign as well as American cotton. In general, foreign mills using U. S. and other cottons do surface cleaning before processing on a much larger proportion of U. S. bales than of foreign cotton, and the cost per bale cleaned is proportionately much greater for U. S. cotton. The study also gives attention to the possible effects of the shortcomings of the U. S. bale package, including those due to sampling, on other segments of the industry.

The foreign phases of the cotton bale packaging studies, like the domestic phases, do not provide separate cost estimates of the effects of sampling practices. However, they clearly indicate that the conventional method of sampling accounts for a part of the overall shortcomings of the American bale package, as viewed by the spinners of other countries. It is pointed out in the summary report covering the foreign studies that, because of the greater competition from foreign cotton and the lower wages and purchasing power of overseas consumers, the weaknesses of the U. S. cotton bale package have more effect on the purchases of U. S. cotton by foreign mills than by domestic mills. 3/ However, irrespective of the proportion of the total effects which can be attributed to conventional sampling, it should be recognized that under existing trade practices, most mechanically sampled bales also may be hand

3/ Cooper, Maurice R., and McRae, R. Herschel. The American Bale Package and Our Foreign Markets. U. S. Dept. Agr., Agr. Mktg. Serv. and For. Agr. Serv., AMS-386, June 1960.

sampled one or more times before reaching domestic and foreign mills. Consequently mechanical sampling eliminates only a part of the costs to spinners resulting from cut sampling.

Growers' Opinions and Suggestions

Of the producers patronizing gins with mechanical samplers to whom questionnaires were sent, 153 returned usable schedules. Ninety-seven of these producers, accounting for approximately one-half of all the bales produced, reported that all of their cotton was sampled mechanically. The remaining 56 producers reported, on the average, about 52 percent of their crop sampled mechanically and 48 percent sampled by cutting. Altogether nearly three-fourths of all the bales produced by the responding producers were sampled mechanically. Mechanical failure of sampling machines accounted for some of the cut samples, but most of them were due to farmers' having part of their crop ginned at gins not equipped with mechanical samplers.

All but 2 of the 153 growers reported that if all conditions and equipment at two gins were the same, except that one had a mechanical sampler and the other did not, they would prefer the gin with mechanical sampler. The two producers who did not prefer the mechanical sampler said that the buyers in their area did not like mechanically drawn samples and tended to discriminate against them. One of these producers expressed the view that the mechanically drawn sample did not represent the bale of cotton. The two producers did not think that this method of sampling offered any advantages.

The advantage of mechanically drawn samples most frequently mentioned by growers was that they were more representative of the contents of the cotton bale (table 9). Another popular feature of mechanical sampling with growers was that it eliminates or reduces the necessity of cutting the bale wrapping and therefore provides a neater and more attractive bale for merchandising. About one-fifth of the growers felt that mechanically drawn samples were easier to handle and store and that they save time at the gin. A number also indicated that they believed the marketing agencies in their area preferred mechanically drawn samples.

Of the 151 growers preferring mechanical sampling, 84 responded to the question on the disadvantages, if any, of this method of sampling. Over one-half of these said that automatic sampling had no disadvantages (table 10).

Among the remaining growers, the major complaint was that mechanical difficulties prevented the sampler from sampling all bales. These growers felt that the best way to make the mechanical sampler acceptable was to make the machine more durable and its operation less complicated. Ten percent of the 84 growers completing this part of the schedule reported that buyers preferred cut samples and therefore discriminated against mechanically drawn samples. Another 10 percent believed that mechanically drawn samples were inferior in some respects to cut samples for determining the quality of cotton in the bale. These growers indicated that mechanically drawn samples dry out faster than cut samples, they are too dense, their appearance is poorer, and Government classers sometimes do not class them as high as they would class cut samples.

Table 9.--Advantages of mechanical sampling of cotton bales as reported by 151 cotton growers who prefer mechanical sampling to cut sampling, United States, 1957-58 season

Advantages	Number of producers	Percent of total
Samples are more representative of bale contents	131	87
Method eliminates or reduces cutting bale wrapping and surface	126	83
Samples save time and are easier handled	27	18
Samples are preferred by marketing agencies	23	15
Method requires less cotton for the sample	6	4
Other	4	3

Table 10.--Disadvantages of mechanical sampling of cotton bales as reported by 84 cotton growers who prefer mechanical sampling to cut sampling, United States, 1957-58 season

Disadvantages	Number of producers	Percent of total
None	48	57
Mechanical difficulties with the sampler	13	15
Cut samples preferred by buyers	8	10
Inferior to cut sample in determining quality	8	10
Cost of the sampler	4	5
Requires more work or additional personnel	4	5
Other	3	4

Ginners' Opinions and Suggestions

Ginners surveyed felt that mechanically drawn samples represented bale contents as well as or better than cut samples do. Of the 28 ginners commenting 26 expressed the belief that mechanically drawn samples represented the bale better than cut samples and 2 said they represented it equally well.

Three of the ginners expressed the view that Government classers disliked mechanically drawn samples, partly because of problems involved in handling and disposing of the paper wrappers containing the samples.

More than one-half of the ginners reporting said that their growers favored mechanical sampling. Two ginners felt that growers did not favor this method of sampling, while the other ginners said that in general their growers were neutral.

Sixteen of the 23 ginners reporting thought that merchandising firms, as contrasted to cooperative associations, did not favor mechanically drawn samples.

Three ginners indicated the view that mills were beginning to favor mechanically drawn samples and two felt that warehouses liked the samples.

Most of the gin managers or owners surveyed said that if their gins did not have mechanical samplers they would recommend installing them. However, four of the ginners surveyed felt that the sampler had not been developed to the extent of being reliable. Three of these ginners had unsatisfactory experiences in 1957-58; samplers installed in these gins failed to sample 17, 35, and 58 percent of the bales ginned that season.

Gin managers' and owners' preferences as to the length of sample package produced varied with location of the gins. Six of seven ginners reporting in States other than California preferred 27-inch samples. In California 15 of 18 ginners preferred 18-inch sample packages. A survey made in 1959-60 might well show a larger proportion favoring the larger package, since most of the samplers installed since 1957-58 give an original package 27 inches long, and most gin managers and owners surveyed in 1957-58 indicated a preference for the sizes which were in their gins.

Most of the recommendations given by ginners for improving the sampler were general, with more than half of them related to the mechanical operation of the sampler. These ginners felt that the sampler should be made more durable and less complicated to operate. Other recommendations were directed toward minor changes in design and operation of the sampler.

Information from Merchants and Spinners

The 16 cotton merchandising firms and 2 cooperative marketing associations contacted handled a total of about 234,000 bales of 1957-crop cotton from gins equipped with mechanical samplers. They obtained mechanically drawn samples for 203,000 of these bales. Roughly 93 percent of the latter were handled by the two associations. The association officials not only favored this method of sampling but paid for the samples and added 1 pound of the gin weight of these bales to compensate for the cotton removed prior to sampling. They, however, did indicate disappointment over the number of bales some of the samplers missed and expressed the view that efforts should be made to provide equipment which would be less complicated and less expensive.

Eleven of the 16 merchandising firms obtained mechanically drawn samples for all their purchases from gins with these samplers, and 4 obtained these samples for 48 to 86 percent of such purchases. One firm handled a limited

number of bales from gins with samplers but did not obtain any of the mechanically drawn samples. Few of the 16 firms made use of mechanical samples, because of their lack of experience with such samples, the uncertainty of the comparative quality outturns of lots when based on the two types of samples, and the natural tendency for classers and others to dislike the changes or adjustments associated with new developments.

Of the 11 cotton spinning mills contacted, 4 reported having purchased mechanically sampled cotton during 1957-58 or 1956-57. Respondents for three of the four mills indicated they liked the idea of sampling from inside the bale and the elimination or reduction in the number of sample holes. Even so, none of them indicated a willingness to give any inducement for shipments of cotton without sample holes.

ADVANTAGES AND DISADVANTAGES OF MECHANICAL SAMPLING

Most of the producers, ginners, classers, merchants, and spinners from whom information was obtained indicated that in their opinion mechanical sampling had at least some advantages as well as disadvantages.

The advantages of mechanical sampling over cut sampling most frequently mentioned in these segments of the industry were:

1. Mechanical samples are more representative of bale contents.

2. Mechanical sampling eliminates or reduces the cutting of bale covers, thereby providing more desirable bales.

3. Mechanical sampling saves time and gives samples that are more easily handled.

4. Buyers prefer mechanical samples.

5. Thickness, width, and length of mechanical samples are better than for cut samples.

6. Mechanical sampling requires less cotton.

7. Mechanical samples require less time for classing.

The disadvantages most frequently mentioned by those participating in the surveys were:

1. Mechanical samples are less desirable in dimensions--and in characteristics such as "feel," "appearance," moisture, and density for determining quality.

2. Mechanical samples require more time for classing.

3. Because of mechanical difficulties, the samplers often fail to sample a number of bales.

4. Mechanical samplers are expensive to own and to use.

5. Buyers prefer cut samples.

6. Value of cotton in mechanical samples is lost because bales are weighed after samples are taken.

7. Mechanical and cut samples for the same bale are not the same quality because they are taken from different parts of the bale.

One other point which has been given as an advantage, is that mechanical sampling may be subject to less manipulation than cut sampling. Some other disadvantages mentioned by at least some of the persons contacted are: (1) Mechanical samples can only be taken at the time of ginning, (2) samples are often taken which are not used as samples, and (3) the properties of stored samples may not change in the same manner and to the same extent as cotton inside the bale.

Some of the reported advantages are in direct conflict with some of the indicated disadvantages. The apparent conflict of views is partly due to the fact that some respondents who have had little personal experience with mechanical sampling base their opinions on conjectures and misunderstandings. However, conditions differ from one area to another, and persons who have actually used mechanical samples have not always had identical experiences with them. Also some of the respondents knowingly or unknowingly expressed views which were biased because they believed the new practice would be to their personal advantage or disadvantage.

Irrespective of their recognized weaknesses, these lists of advantages and disadvantages indicate the major features of the new sampling method and of the resulting samples which should be given particular attention by those interested in using or improving the samplers and the samples. Attention also should be given to the particular conditions or situations prevailing at a given gin, local market area, or elsewhere.

LIMITATIONS OF MECHANICAL SAMPLING

Mechanical cotton bale sampling in its present stage of development has some important limitations and shortcomings just as the conventional method of sampling has. If the use of this new method is to continue and expand at a reasonable rate and with a minimum of difficulties to the cotton industry, the limitations and shortcomings must be recognized and those who can do so should help correct or overcome them. Consequently, even though some of them are indicated or implied in earlier sections of this report, these and others are summarized here.

The most important limitations and shortcomings are:

1. Costs of owning or leasing and operating existing samplers are such that sampling costs per bale would be exceptionally high for gins with small volumes of ginning even if the sampler missed none of the bales ginned. The high cost is especially important in limiting the increased use of mechanical sampling, because most gins in the United States usually gin 2,000 bales or less per year.

2. The operating difficulties and the high proportion of bales missed in 1957-58 by the average sampler, together with the complicated nature of the samplers, even if improved considerably, will also limit their use. Again these factors are especially significant in view of the number of small-volume gins and because most small gins which might use mechanical samplers are so far from the larger-volume gins that servicing their samplers would be difficult.

3. Timing devices and other features of existing samplers are such that it is difficult to obtain subsamples from the outer portions of the bale from which cut samples are normally obtained. It is especially difficult to get subsamples from the upper or top side of bales, although this part of the bale apparently accounts for a much smaller proportion of the two-sided or plated bales than the part of the bale which is ginned first. To the extent that these outer parts of individual bales differ from interior portions of the bales, mechanically drawn samples will differ, and should differ, from cut samples from the same bales.

4. Valves and conveyor systems in existing samplers are such that, together with air pressures, valve locations, rate and location of flow of lint cotton and trash particles, and other factors, care must be taken to avoid at least some samples which contain "sampler fall" (trashy cotton created by the sampler mechanism), are too small, or are defective in other ways. Obviously, the occurrence of many such samples can materially retard the increased use of mechanical sampling.

5. Existing mechanical samplers can only sample the bale during the time it is being ginned. If the sampler misses a bale or if a sample is recognized as defective, the only recourse is to use the conventional cut sampling procedure with its commonly recognized shortcomings.

6. Cotton classers find differences between mechanical samples and cut samples in appearance, "feel," density, and dimensions. The differences, at least in some instances and for a time, may have some significant effect upon their speed in classing and their grade and staple length classifications. The extent to which these factors affect the classifications in comparison with cut samples after the classers become thoroughly accustomed to the mechanical samples will influence the extent of the resulting problems of trading and classing or other objections.

7. The paper sample wrappers, particularly when made of exceptionally heavy paper, apparently increase the man-minutes per sample involved in

preparing samples for classing, in identifying individual samples, and in handling the sample containers.

8. Where farmers customarily sell their cotton on gin weights, producers may object to the use of mechanical samplers unless an allowance is made for the cotton in the mechanical sampler packages, especially the 27-inch packages.

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U. S. GOVERNMENT PRINTING OFFICE : 1960 O - 556262

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